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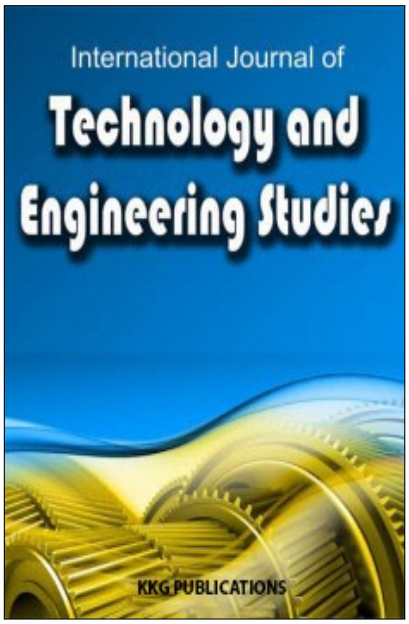

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Determining the Future Demand: Studies for Air Traffic Forecasting

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DETERMINING THE FUTURE DEMAND: STUDIES FOR AIR TRAFFIC FORECASTING

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Abstract. This paper aims to study air traffic models and find an approach for forecasting Singapore's air traffic growth. This study is to identify the actual traffic data and find the top city pair with Singapore FIR. This paper applies the forecasting methodologies to predict the air traffic growth and checks the growth within the region by using simulations and modeling. Specifically, time series analysis was applied in this study. This research uses the Singapore 1998 to 2015 numbers of flights and 2015 June flight plan data for simulations and modeling. Results estimate that WSSS-WMKK will have 286 aircraft movements per day, WSSS-WIII will have 264 aircraft movements per day and WSSS-VHHH will have 152 aircraft movements per day in 2030. Air traffic forecast models would be useful in predicting the growth of air traffic to facilitate the development of technology, operations, and infrastructure for the aviation industry.

INTRODUCTION

Air transportation has seen a rapid growth each year and ICAO estimated a growth rate of 6.3% for the whole world. Within Asia-Pacific itself, the number of aircraft departures increased from about 4,000,000 in 2006 to nearly 8,000,000 in 2014, a growth of approximately 200% in less than 10 years [1]. For South East Asia, ICAO estimated an annual growth rate of 6.7% for passenger traffic over 2010-2030 [2]. With this rapid rise in traffic, there is a possibility of problems of airport and air traffic control congestion [3].

Another motivation for forecasting of air traffic growth is related to environmental concerns. Previous studies done in Europe illustrate the impact of increasing air traffic on the environment [4], [5].

A civil aviation authority requires demand forecasts at many levels for planning and other purposes [6]. At the strategic level, forecasts are required for long-term planning over time periods of 10-20 years [6].

Time series analysis was applied in this study. This paper focuses on the long term forecasting of the growth rate and amount of traffic in the future for Singapore.

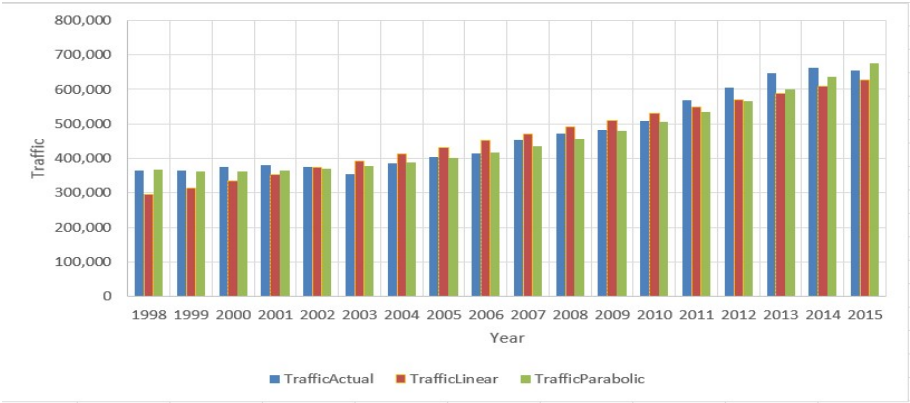

Fig. 1 . Singapore 18 years air traffic

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THE DATA

This study is not only to identify the actual traffic data but also to find the top city pair with Singapore FIR. This study uses the Singapore 1998 to 2015 numbers of flights and 2015 June flight plan data for simulations and modeling. The data were validated by referring to the number of flights from Wikipedia (Singapore Changi Airport) [7].

TIME SERIES ANALYSIS

A time series is a set of observations measured sequentially through time. These measurements may be made continuously through time or be taken at a discrete set of time points [8]. Time series analysis is applied widely for forecasting in various fields, such as forecasting of wheat production [9] and the impact of diseases [10].

Forecasting using trend projection is one of the methods of time-series forecasting. Trend projection methods use the underlying long-term trend of a time series of data to forecast its future values [11]. For time-trend projection, the forecasting assumes that the general trends in demand seen over time in the past will pertain in the future [12]. The number of traffic to be forecasted is plotted on the vertical axis and time (year) is plotted on the horizontal axis in this study.

For this paper, the trend in air traffic growth is represented by two different types of trend curves.

- Linear Trend:

$$\mu_t = \alpha + \beta t \tag{1}$$

- Parabolic Trend:

$$\mu_t = \alpha + \beta t + \gamma t^2 \tag{2}$$

For both equations, μ_t is traffic, t is time (normally in years), α, β and γ and are constants [8], [13].

RESULTS AND DISCUSSION

Figure 1 shows the relationship between time (t) and traffic (μ_t) for Singapore air traffic from 1998 to 2015. By using 18 years of air traffic data the following relationships were obtained:

- For the linear trend,

$$\mu_t = 470,700 + 104,500t \tag{3}$$

Where 470,700 is the intercept, and 104,500t is the gradient.

- For the parabolic trend,

$$\mu_t = 37,940\left(\left(\frac{T-2007}{5.339}\right)^2\right) + 104,500\frac{T-2007}{5.339} + 434,800 \tag{4}$$

Where 37,940 is the intercept, 104,500 and 434,800 are the coefficients respectively. 2,007 is the mean and 5.339 is the standard deviation.

As observed in Figure 1, there is a gap between the linear graph and actual traffic graph, while the parabolic graph is fairly accurate except at the mid of 2010 to 2014.

Figure 2 shows the extrapolation of air traffic using both linear and parabolic trends, up to 2030. Using the linear trend, the average annual growth rate was calculated to be 3% and the amount of traffic was estimated to be 920,878 by 2030. The R-Square value for this study is 0.8877.For the parabolic trend, the average annual growth rate was calculated to be 6% and the amount of traffic was estimated to be 1,589,076 by 2030. The R-Square for this study is 0.9752.

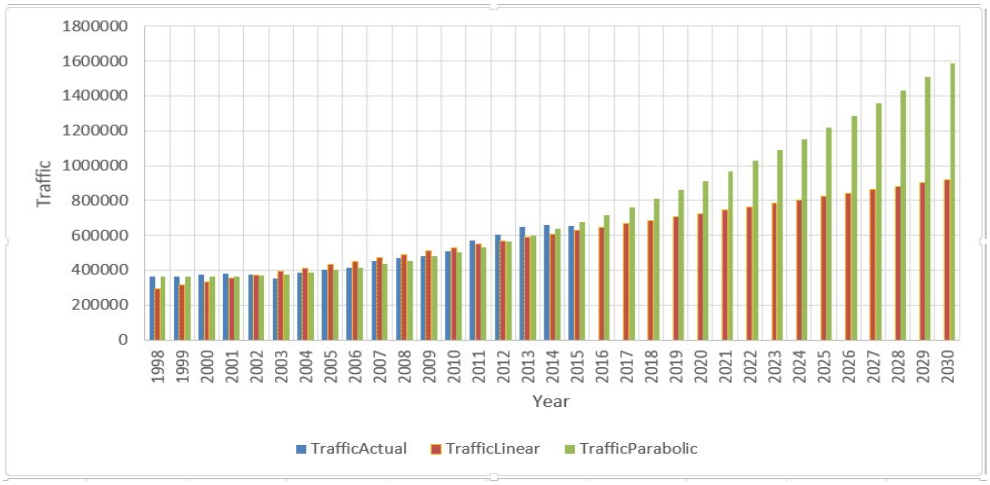

Fig. 2 . Singapore air traffic forecast for next 15 years

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Figure 3 shows the Singapore air traffic in 2030 simulated based on a 3% growth rate. The green aircraft represent the current traffic and the red aircraft are additional aircraft.

Figure 4 shows the Singapore air traffic in 2030 simulated based on a 6% growth rate. The green aircraft represent the current traffic and the red aircraft are additional aircraft.

Based on the 3% growth rate, this study brings top 3 city pairs out of 5. This study estimates that WSSS-WMKK has 203 aircraft movements per day, WSSS-WIII has 196 aircraft movements per day and WSSS-VHHH has 115 aircraft movements per day in 2030.

Based on the 6% growth rate, this study brings top 3 city pairs out of 5.

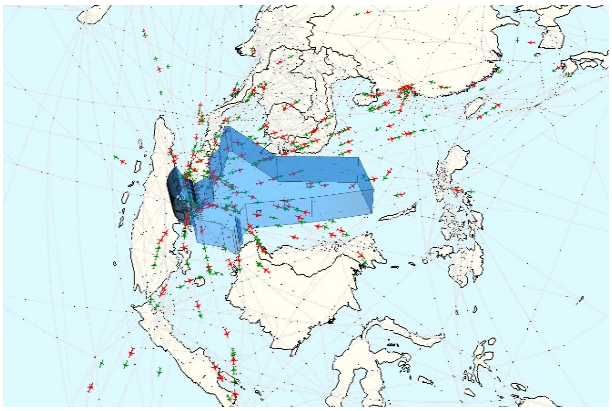

Fig. 3 . Singapore air traffic in 2030 based on a 3% growth rate

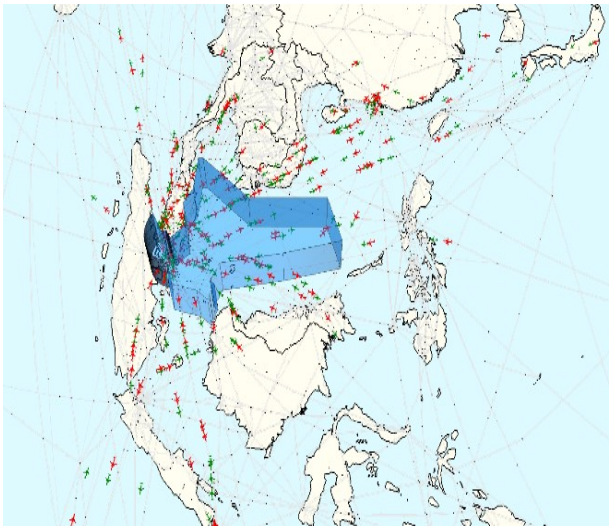

Fig. 4 . Singapore air traffic in 2030 based on a 3% growth rate

This study estimates that WSSS-WMKK has 286 aircraft movements per day, WSSS-WIII has 264 aircraft movements per day and WSSS-VHHH has 152 aircraft movements per day in 2030.

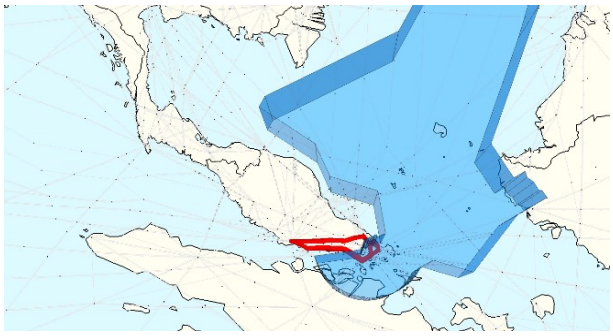

Fig. 5 . City pair between WSSS_WMKK

Figure 5 shows the city pair scenario between Singapore Changi Airport (WSSS) and Kuala Lumpur International Airport (WMKK).

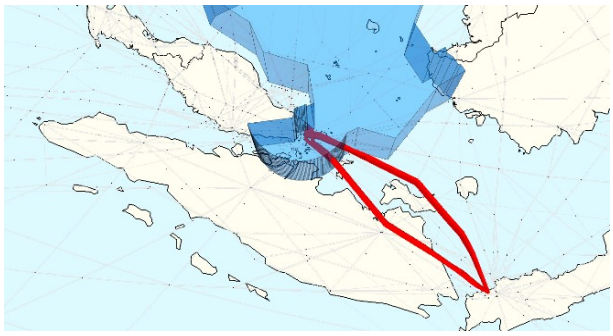

Fig. 6 . City pair between WSSS_WIII

Figure 6 shows the city pair scenario between Singapore Changi Airport (WSSS) and SoekarnoHatta International Airport (WIII).

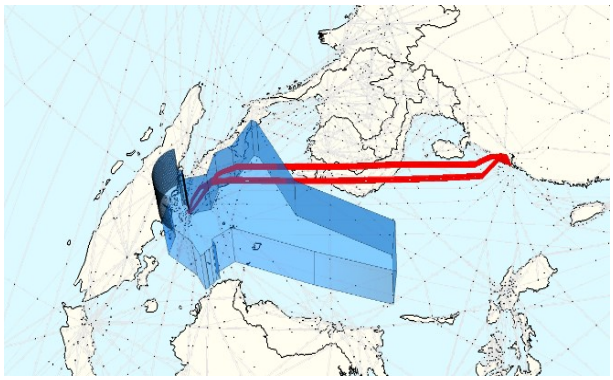

Fig. 7 . City pair between WSSS_VHHH

Figure 7 shows the city pair scenario between Singapore Changi Airport (WSSS) and Hong Kong International Airport (VHHH).

CONCLUSION AND RECOMMENDATIONS

The trend projection method was used to predict the air traffic growth rate and amount of traffic for Singapore in the next 15 years. Future work could target research of other methodologies to predict the traffic growth rate and traffic amount, such as ARIMA(X) and exponential smoothing [14]. It is often argued that the air passenger transport activity is closely related to economic activities, usually reflected in the Gross Domestic Product (GDP) [15]. Thus, there could be future studies to explore this relationship for ASEAN.

Declaration of Conflicting Interests

There are no conflicts of interest.

Acknowledgement

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